PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

19 APR 2005

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference BA9314PCT	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/US 03/37668	International filing date *(day/month/year)* 20.11.2003	Priority date *(day/month/year)* 27.11.2002
International Patent Classification (IPC) or national classification and IPC G01N15/02		
Applicant E.I. DU PONT DE NEMOURS AND COMPANY et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 3 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
21.06.2004	16.03.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Müller, T Telephone No. +49 89 2399-2285

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US 03/37668

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-37	as originally filed
Claims, Numbers	
1-23	received on 26.01.2005 with letter of 25.01.2005
Drawings, Sheets	
1/8-8/8	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US 03/37668

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: EP-A-0 475 121 (BUEHLER AG) 18 March 1992 (1992-03-18)
D2: US-A-5 917 927 (SATAKE SATORU ET AL) 29 June 1999 (1999-06-29)
D3: WO 94/06092 A (SJOESTEDT LENNART ;SOEDERLUND PATRIK (SE); AGROVISION AB (SE); OES) 17 March 1994 (1994-03-17)
D4: PATENT ABSTRACTS OF JAPAN vol. 1996, no. 08, 30 August 1996 (1996-08-30) & JP 08 089780 A (TOKAI CARBON CO LTD), 9 April 1996 (1996-04-09)

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows in one embodiment related to figure 8A and the corresponding description (the references in parentheses applying to figure 8A of D1):
A method and a device for sorting particles comprising a particle feeder (87.1), an inclined surface having an upper inlet located adjacent to and below the exit end of the feeder, a source of illumination (115), and a CCD camera (201), that is an image receiver. An image analysis unit is adapted to detect the colour of the particles that is a composition calculator which converts reflective light image signals received from the image receiver into data indicative of particle types based on at least one optical property of the particles.

The subject-matter of claim 1 differs from this known method in that

- the proportion of at least one particle type in a mixture is calculated whereas in D1 the particles are sorted into storage containers

- the particles are fed to a smooth planar stationary surface and descend along the inclined surface through the force of gravity whereas in the embodiment of figure 8 of D1 the particles move on a conveyor belt with indentations for receiving the particles

The subject-matter of claim 1 is therefore new over the embodiment related to figure 8A of D1.

In another embodiment of D1, as disclosed in figure 1 and the corresponding description, particles are indeed fed to a smooth planar stationary surface and descend along the inclined surface through the force of gravity. However, in that embodiment of D1 the inclined surface belongs to a preprocessing stage to identify "good" particles for further investigation and subsequent sorting and has to be regarded as the feeder. Therefore claim 1 of the present application differs from the method related to figure 1 of D1 in that

- the proportion of at least one particle type in a mixture is calculated whereas in D1 the particles are sorted into "good" particles which are further investigated and other particles falling into a funnel

- the mixture is fed from a feeder located adjacent an upper inlet end of the inclined surface and capable of being positioned at a distance no greater than the smallest dimension of the particles

The subject-matter of claim 1 is therefore new over D1 (Article 33(2) PCT).

A similar argument would apply to the corresponding independent apparatus claim 20.

The problem to be solved by the present invention may be regarded as minimizing the amount of touching particles when feeding a mixture of particles to a surface and calculating the proportion of at least one particle type based on data from optical properties or shape.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

D1 discloses as a solution a conveyor belt with grooves for minimizing the amount of grains touching each other and no hint is given replace that conveyor belt by an inclined surface. D2 and D3 employ also conveyor belts for feeding the particles to devices for optical investigation. D4 discloses an inclined surface (21), but granulated particles of one type only are falling onto the surface and positioning of a feeder at a distance no greater than the smallest dimension of the particles for minimizing the amount of touching grains is not hinted. Therefore the combination of

- feeding the mixture from a feeder located adjacent an upper inlet end an inclined surface and capable of being positioned at a distance no greater than the smallest dimension of the particles
- employment of a smooth planar stationary surface where particles descend along the inclined surface through the force of gravity

is not derivable from a combination of the cited prior art documents.

A similar argument would apply to the corresponding independent apparatus claim 20.

Claims 2-19 and 21-23 are dependent on the independent claims and as such also meet the requirements of the PCT with respect to novelty and inventive step.

What is claimed is:

1. A method for determining the proportion of differing particle types in a mixture, comprising:

(i) feeding a mixture comprising at least two particle types of non-cohesive particles, each particle type having at least one optical property and/or shape differing from another particle type, from a particle feeder having an exit end to a smooth, planar, stationary surface inclined at an angle sufficient to enable the particles to descend along the surface through the force of gravity, said surface having an upper inlet end located adjacent to and below the exit end of the feeder and capable of being positioned at a distance no greater than the smallest dimension of the particles;

(ii) illuminating the particles along the inclined surface;

(iii) collecting reflective-light images of the illuminated particles; and

(iv) calculating the proportion of at least one particle type based on data from the reflective light images indicative of the at least one differing optical property and/or shape.

2. The method of claim 1, wherein the at least one optical property is at least one of reflectance, luminescence and variations thereof at visible, ultraviolet and infrared wavelengths.

3. The method of claim 2 further comprising calculating at least one dimensional property.

4. The method of claim 3, wherein the at least one dimensional property is at least one of longest dimension, shortest dimension, area and perimeter.

5. The method of claim 1, wherein the inclined surface is about 60° or less from horizontal.

6. The method of claim 1, wherein the reflective-light images are collected at about perpendicular to the inclined surface.

7. The method of claim 1 further comprising adjusting the feed rate of the particles as they are fed from the feeder to the inclined surface based on feedback received from the calculating step.

8. The method of claim 7, wherein the feed rate is adjusted to provide that less than 25% of the particles on the inclined surface are touching another particle in the reflective-light images.

9. The method of claim 8, wherein the feed rate is adjusted to provide that less than 10% of the particles on the inclined surface are touching another particle in the reflective-light images.

10. The method of claim 9, wherein the feed rate is adjusted to provide that less than 2% of the particles on the inclined surface are touching another particle in the reflective-light images.

11. The method of claim 1, wherein the non-cohesive particles are non-spheroidal and the inlet end of the inclined surface is positioned to provide that at least 80% of the particles have a bounce angle of 10 degrees or less.

12. The method of claim 11, wherein the inlet end of the inclined surface is positioned to provide that at least 90% of the particles have a bounce angle of 10 degrees or less.

13. The method of claim 11, wherein the inlet end of the inclined surface is positioned to provide that at least 95% of the particles have a bounce angle of 10 degrees or less.

14. The method of claim 1, wherein the mixture of non-cohesive particles comprises particles substantially cylindrical in shape.

15. The method of claim 1, wherein the mixture of non-cohesive particles comprises particles having a shape substantially cylindrical with a circular cross-section.

16. The method of claim 1, wherein the mixture of non-cohesive particles comprises seed.

17. The method of claim 1, wherein the mixture of non-cohesive particles comprises particles comprising at least one agriculturally active material.

18. The method of claim 1, wherein the mixture of non-cohesive particles comprises particles comprising at least one crop protection agent.

19. The method of claim 1, further comprising blowing an inert gas nearly parallel but slightly downward towards the inclined surface to remove any dust present.

20. An apparatus for determining the proportion of particles of differing particle types in a mixture comprising:

(i) a particle feeder having an exit end;

(ii) a smooth, planar, stationary surface inclined sufficiently to enable descent of non-cohesive particles down the surface through the force of gravity, said inclined surface having an upper inlet end located adjacent to and below the

exit end of the feeder and capable of being positioned at a distance no greater than the smallest dimension of the particles to be measured;

(iii) a source of illumination oriented with respect to the inclined surface so as to enable top-illumination of the particles as they descend down the inclined surface;

(iv) an image receiver oriented with respect to the inclined surface so as to enable collection of reflective-light images of the particles as they descend down the inclined surface; and

(v) a composition calculator which converts reflective-light image signals received from the image receiver into data indicative of at least one proportion of particle types in the mixture based on at least one optical property and/or shape of the particles.

21. The apparatus of claim 20 wherein the image receiver comprises a color camera.

22. The apparatus of claim 20 further comprising a feed controller having a mode for receiving feedback from the composition calculator for controlling the feed rate of the particles.

23. The apparatus of Claim 20 further comprising a gas nozzle for blowing a gas stream nearly parallel but slightly downward towards the inclined surface.